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A Historical Review of Training Requirements for Unmanned Aircraft Systems, Small Unmanned Aircraft Systems, and Manned Operations (1997-2014)

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16. Abstract <p>There are several mature Unmanned Aircraft System (UAS) and Small Unmanned Aircraft System (sUAS) training programs available for analysis. Many of these programs were developed by the various branches with the U.S. Department of Defense (DoD) in conjunction with UAS manufacturers. The structures of the existing training programs guided the creation of a general framework with the understanding that training programs might differ depending on variables such as the type, size, and mission of a particular UAS. Many common elements are found across existing DoD training programs and the Practical Test Standards (PTS), oral test, and knowledge test requirements for manned aircraft defined by the FAA under Title 14 Code of Federal Regulations (CFR) Part 61. This document reviewed and capitalized on the knowledge gained by Unmanned Aircraft (UA) pilots through many thousands of hours of operations as reflected in published training procedures. This review follows a structure based on that provided within the FAA PTS documentation, with additions where the specific content of UAS training programs dictates. Each section will discuss the requirements of the various UAS programs and point to general similarities between the manned and UAS training requirements. Knowledge requirements are discussed that are found in the PTS for manned systems and are not discussed in current UAS training documentation but may be applicable to UAS operations in the National Airspace System (NAS).</p>					
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EXECUTIVE SUMMARY

There are several mature Unmanned Aircraft System (UAS) and Small Unmanned Aircraft System (sUAS) training programs available for analysis. Many of these programs were developed by the various branches with the U.S. Department of Defense (DoD) in conjunction with UAS manufacturers. Additionally, the Joint Chiefs of Staff (JCS) have directed the development of broad guidelines for UAS/sUAS training programs. The guidance from the JCS was used to create a general framework with the understanding that training programs might depart either in micro or macro ways depending on variables such as the type, size, and mission of a particular UAS.

Many common elements are found across the existing DoD training programs. Additionally, these training programs share many commonalities with the extant Practical Test Standards (PTS), oral test, and knowledge test requirements for manned aircraft defined by the FAA under Title 14 Code of Federal Regulations (CFR) Part 61. The guidance from the JCS and many of the existing UAS training programs followed manned aircraft standards to varying degrees. Organizations that operate sUAS/UAS have updated, or modified, these standards as operations have evolved. This document seeks to review and capitalize on the knowledge gained by these Unmanned Aircraft (UA) pilots through many thousands of hours of operations as reflected in updates to their published training procedures.

This document review follows a structure based on that provided within the FAA PTS documentation, with additions where the specific content of UAS training programs dictates. Each section will discuss the requirements of the various UAS programs and point to general similarities between the manned and UAS training requirements. Knowledge requirements are discussed that are found in the PTS for manned systems and are not discussed in current UAS training documentation but may be applicable to UAS operations in the NAS.

A HISTORICAL REVIEW OF TRAINING REQUIREMENTS FOR UNMANNED AIRCRAFT SYSTEMS, SMALL UNMANNED AIRCRAFT SYSTEMS, AND MANNED OPERATIONS (1997-2014)

INTRODUCTION

Historically, UA pilots were required to possess a manned aircraft certification for most operations. FAA document N8900.227, “Unmanned Aircraft Systems (UAS) Operational Approval,” defined the types of operations in which a manned pilot certificate was required and the level of certification that was required. Paragraph 16(C)(2)(b) of that document stated that the pilot-in-command (PIC) needed to hold, at a minimum, an FAA private pilot certificate or FAA-recognized equivalent for all operations listed below:

- Flight in Class A, B, C, D, E, and G (400 feet above ground level (AGL)) airspace.
- IFR (must have instrument rating) operations.
- Night operations.
- At joint use or public airfields.
- Requiring a chase aircraft.
- At any time the FAA has determined the need, based on the UAS characteristics, mission profile, or other operational parameters.

In addition, operations in which a manned pilot certification was not required were constrained by the following conditions:

- The PIC had to successfully complete, at a minimum, FAA private pilot ground instruction and pass the FAA Private Pilot written examination or FAA-recognized equivalents.
- Operations during daylight hours only.
- The operation conducted in a sparsely populated location.
- Operations approved and conducted solely within visual line-of-sight in Class G airspace.
- Visual line-of-sight operations conducted no further than ½ NM laterally from the UAS pilot and at an altitude of no more than 400 feet AGL at all times.
- Operations conducted no closer than 5 NM from any FAA-designated airport or heliport other than the airport from which the aircraft was operating.
- The operation conducted from a privately owned airfield, military installation, or off-airport location.

(Paragraph 16(C)(2)(c))

Despite the many similarities between manned and unmanned aircraft, there were portions of manned aircraft pilot training curricula that were not found in the UAS training protocols. In addition, there are aspects of flying UAs that do not apply to manned aircraft flight. Because of these dissimilarities, it is expected that eventually, there will be UA-specific pilot certifications that will not require any manned aircraft pilot certification. This has already occurred for many current military UA pilot training programs and small UAS operations under Part 107.

There are numerous training protocols in existence for the current fleets of UAS. Many of these training programs are proprietary or classified. However, we were able to obtain a set of publically available protocols on UAS training that span the range from small (e.g. Raven, Scan Eagle) to larger UAS (e.g. Hunter, MQ-1/9). The purpose of this report is to highlight the key areas that are contained within these training protocols, providing comparison and contrast to the current set of manned Practical Test Standards (PTS). We also reviewed the manned and unmanned standards from the Civil Aviation Safety Authority (CASA) of Australia because of the strong similarities to the U.S. manned standards and the maturity and completeness of the CASA unmanned standards.

METHOD

The gathering of current unmanned training protocols was accomplished through reviewing published online materials and contacting personnel from the U.S. military and industry with ties to unmanned training. In addition to unmanned training protocols, we also collected manned aircraft training material and requirements. *Table 1* is a listing of the protocols collected for review. In addition to these, an independent Subject Matter Expert (SME), with experience in defining training requirements for currently fielded UAs, provided a detailed listing of their suggested unmanned ground school topics for comparison. We included the SME suggestions as a point of reference, or crosscheck, to the published requirements located during our separate review of the training protocols.

Published UA training protocols are informative for the following reasons: (1) Many of these platforms have been in operation for years and have accumulated, in some instances, many thousands of hours of operational experience (e.g., MQ-1, Hunter). (2) The training for these pilots has been adapted based on this experience and feedback from operational personnel.

Table 1. Reviewed Training Protocols

Title	Abbreviation	Authoring Organization	Year
14 CFR Part 61 – Certification: Pilots, flight instructors, and ground instructors	Part 61: (Recreational) Part 61: (Private) Part 61: (Instrument) Part 61: (Commercial) Part 61: (ATP)	Federal Aviation Administration	2014
Airline Transport Pilot and aircraft type rating practical test standards for airplane (FAA-S-8081-5F with Changes 1, 2, 3, 4, 5, 6, & 7)	PTS ATP	Federal Aviation Administration	2008
Commercial pilot practical test standards for airplane (SEL, MEL, SES, MES) (FAA-S-8081-12C with changes 1, 2, 3, and 4)	PTS Commercial	Federal Aviation Administration	2011
Group 1 unmanned aircraft systems (UAS) training and readiness (T&R) manual (United States Navy NAVMC 3500.07)	USN/USMC: sUAS	United States Navy	2012
Instrument rating practical test standards for airplane, helicopter, and powered lift (FAA-S-8081-4E with Changes 1, 2, 3, 4, & 5)	PTS Instrument	Federal Aviation Administration	2010
Joint unmanned aircraft systems minimum training standards (CJCSI 3255.01)	JCS: BUQ-I (Recreational) JCS: BUQ-II (Private) JCS: BUQ-III (Instrument)	Joint Staff	2011
MQ-1 aircrew training (Air Force Instruction 11-2MQ-1, Volume 1)	USAF: (MQ-1) UAS	United States Air Force	2010
MQ-9 crew training (Air Force Instruction 11-2MQ-9, Volume 1)	USAF: (MQ-9) UAS	United States Air Force	2010
Private pilot practical test standards for airplane (SEL, MEL, SES, MES) (FAA-S-8081-14B with changes 1, 2, 3, 4, 5, & 6)	PTS Private	Federal Aviation Administration	2011
Recreational pilot practical test standards for airplane, rotorcraft/helicopter, and rotorcraft/gyroplane (FAA-S-8081-3A)	PTS Recreational (RPA)	Federal Aviation Administration	2006
Small unmanned aircraft system aircrew training manual (United States Army Training Circular No. TC 1-611)	USA: sUAS	United States Army	2006
Small unmanned aircraft systems training (Air Force Instruction 11-502, Volume 1)	USAF: sUAS	United States Air Force	2012
Unmanned aerial vehicle aircrew training manual (United States Army Training Circular No. TC 34-212)	USA: UAS (Hunter)	United States Army	1997

Title	Abbreviation	Authoring Organization	Year
Unmanned aircraft and rockets: Unmanned aerial vehicle (UAV) operations, design specification, maintenance and training of human resources CASA AC-101-1(0)	CASA Unmanned	Civil Aviation Safety Authority Australia	2002

After collecting the training protocols, we began a detailed comparison of the protocols to each other and to current manned training PTSs for Private, Commercial, and ATP certifications, as well as the Instrument rating PTS. A checklist was created to easily view differences across the reviewed protocols. (See *Appendix A* to review the requirements checklist tabulated by each training protocol. See *Appendix B* to review the requirements by training protocol then evaluated by manned and unmanned system categories). Current training requirements were grouped into several categories:

- *Current UAS/sUAS (only): Present in current Unmanned training with no readily apparent analog in the manned community*
- *Current UAS/sUAS and Manned: Present in current Unmanned training with an analog in the manned community*
- *Manned only (Excluded from UAS/sUAS training): Not present in Unmanned training but present in the manned community*

FINDINGS

We found that the training protocols had many of the same general categories and specific requirements. The general categories typically followed those outlined in Part 61 for Knowledge and Flight Proficiency requirements for the private, commercial, instrument, and ATP ratings. The nexus between UAS, sUAS, and manned training and testing allowed construction of a single set of high-level categories labeled as follows.

- Policy and responsibilities
- Preflight preparation
- Communications
- Weather information
- Flight authorization, approval, and clearance authority
- Preflight procedures
- Airport Operations (launch/landing area)
- General flight operations
- Takeoff and departure
- Maneuvers
- Emergency Operations

- Slow flight and stalls
- Navigation
- Landings and approaches to landing (Recovery)
- Postflight procedures
- Visual flight rules (VFR)
- Instrument flight rules (IFR)
- Normal operating procedures
- Safety/Operational risk management
- Reporting procedures

The categorization of training requirements resulted in a number of training requirements within each of the three categories. The following sections discuss each of those categories in turn. Appendix A contains the full list of requirements compared across protocols. Those requirements were divided into categories based on inclusion in reviewed training protocols. The following three sections discuss, by category, the relationships between current manned and UA training requirements.

A. Current UAS/sUAS: Present in current Unmanned training with no analog in the manned community

Training *present in current Unmanned training with no analog in the manned community* included the necessity of training the UA pilots on topics that are outside of the scope of manned operational requirements and can reasonably be expected to remain so, such as Certificates of Authorization (COAs) and interactions with visual observers. Certain UAs also require a ground crew to launch and/or recover the aircraft. The interactions with this crew are not something that have a direct analog in manned operations and may vary significantly between UAs.

The currently reviewed protocols did not discuss requirements regarding visual observer(s), formation flight, cooperative teaming, or swarming within sUAS operations. Visual Observer training requirements have not been established for unmanned operations in the NAS. Formation Flight/ Cooperative Teaming and Swarming operations are also a limited subset of unmanned operations, and training may take many forms as these operations develop and evolve. Manned training and testing requirements do not include practice of formation flight, and the only restriction that is placed on formation flights is that they must be undertaken only with the agreement of each pilot in command involved (14 CFR § Part 91.111 (b)). The use of chase planes is also an area that is still under discussion within the unmanned and regulatory communities.

Table 2 lists the identified training requirement topics that apply to UAS and/or sUAS training, but not to manned aircraft, under the protocols evaluated.

Table 2. sUAS/UAS Pilot Training Requirements, Absent from Manned Operations

Training Requirement A: UAS/sUAS (only)	UAS and/Or sUAS
PREFLIGHT PREPARATION	
Certificates of Authorization (COA) Protocols: USAF: sUAS, USN/USMC: sUAS, UAS Suggested Ground Lesson: SME	UAS, sUAS
Operational Data for Mission Planning¹ [mission specific: e.g., proper topographical maps for surveillance area, order of events, direction of pesticide application] Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), UAS Suggested Ground Lesson: SME	UAS, sUAS
Frequency Coordination [CNPC/command and control frequencies] Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)	UAS, sUAS
Visual Observers [safety O, Supervising O, line of sight O] Protocols: CASA Unmanned, UAS Suggested Ground Lesson: SME	UAS
Control Station (CS) System Checks [checklist/procedures for CS] Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Suggested Ground Lesson: SME	UAS, sUAS
Communications <i>See also nav system/radar service</i>	
Data Links (C2-command & control non-payload comm. CNPC) and Lost Link Procedures <i>See also Emergency Lost Link</i> Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), UAS Suggested Ground Lesson: SME	UAS, sUAS
AIRPORT OPERATIONS (launch/landing area)	
Launch/Recovery Areas (e.g., Rail, slingshot, and hand-thrown launches; net and arresting cable recoveries) Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, UAS Suggested Ground Lesson: SME	UAS, sUAS
GENERAL FLIGHT OPERATIONS	
Formation Flight/ Cooperative Teaming/ Swarming/ Chase planes Protocols: USA: UAS (Hunter), CASA Unmanned	UAS

Night Vision Goggles (NVG) Operations ² [includes night vision device NVD] Protocols: USN/USMC: sUAS	sUAS
UAS Hand-off Procedures Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, UAS Suggested Ground Lesson: SME	UAS, sUAS
LANDINGS AND APPROACHES TO LANDING	
Automatic Approach & Landing³ Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)	UAS, sUAS
NORMAL OPERATING PROCEDURES	
Video/Data Capture [surveillance/camera] Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, UAS Suggested Ground Lesson: SME	UAS, sUAS

¹ Mission planning is not included in manned PTS but is employed in certain manned operations.

² 14 CFR Part §61.31 mandated NVG/NVD training; not included in manned PTS.

³ Automated approach/landing is not included in manned PTS, but covered in other regulations.

The emergency lost link procedures do not have an analog in the manned community. A UAS preprogrammed with an IFR flight plan could continue on its course in the event of a lost link. The major caveat is that the unmanned systems will follow the preprogrammed course precisely, unlike a manned system where course changes may occur at the pilot’s discretion. Just as Air Traffic Control (ATC) would anticipate a manned aircraft with lost communications to operate by the filed and cleared flight plan, the ATC controllers may be expecting the UAS to continue the flight according to the filed flight plan.

In addition, there is a potential that the UA would deviate from the flight plan because of failed or damaged systems on board. In a manned aircraft, the pilot would squawk 7700 using the transponder, alerting ATC of the need for priority treatment and to expect unfiled maneuvers from the aircraft. Similarly, a UA in such a state might deviate from the filed flight plan to avoid populated areas or to divert to an alternate airfield.

NVG/NVD operations in manned aircraft are currently trained outside of the requirements for a certificate. Specifically, the current regulations state that no person may act as pilot in command using NVG/NVD unless ground and flight instruction has been received by an authorized flight instructor and a logbook or training record endorsement is received (CFR 14 Part §61.31).

B. Current UAS/sUAS and Manned: Present in current Unmanned training and in the manned community

There are also areas of UA training that have analogs in manned training. For example, training for both manned and unmanned pilots includes preflight checks of the aircraft. Although UA pilot training includes Control Station (CS) checks, these CS checks should arguably be included in the category of preflight checks of required aircraft components. Table 3 lists those identified training topics that apply to both UA and manned operations.

Table 3. UAS/sUAS and Manned Operations Training Requirements

Training Requirement – B. UAS/sUAS & Manned
POLICY AND RESPONSIBILITIES
<p>Minimum training/currency Standards [frequency/recency/simulator/cockpit/#hrs/proficiency flight/check]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>FAA Advisory Circulars (ACs) and Technical Standard Orders (TSOs) [published standards and regulations]</p> <p>Protocols: USAF: sUAS, USN/USMC: sUAS, CASA Unmanned, Part 61 (Recreational), Part 61 (Private), Part 61 (Instrument), UAS Suggested Ground Lesson: SME</p>
<p>Records - Maintenance and disposition of [total flight time/ flight logs-training records/ engine time]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Instrument), Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>Maintenance of Aircraft/Equipment [performing/requesting mx]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA - BOTH, PTS Recreational (RPA), UAS Suggested Ground Lesson: SME</p>
PREFLIGHT PREPARATION
<p>Pilot Certificates and Documents</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Commercial), PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>Aircraft Certification, Airworthiness and Documents [registration, operating limitation documents, weight and balance information, and any other documents required by regulation, CS documentation]</p>

<p>Protocols: Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Airworthiness Requirements [airframe, subsystem failure checklist, Compliance with all Airworthiness Directives, Minimum Equipment List items, etc.]</p> <p>Protocols: USAF: (MQ-9) UAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Maintenance Logs [track unit device training]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>
<p>Flight Planning [Departure, Arrival, and Computerized Planning]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Crew Briefing <i>See also CRM in Safety/Operational Risk Mgmt.</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61 (Instrument), Part 61 (Commercial), Part 61 ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Navigational Chart/Map Reading</p> <p>Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, Part 61: (Commercial), Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Map/Chart Preparation for Use During Flight</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), Part 61: (Instrument), PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>Publications</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Commercial</p>
<p>International Civil Aviation Organization (ICAO)/Flight Information Publications Procedures</p> <p>Protocols: USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS ATP</p>

<p>Mission Route Selection & Analysis <i>See also Operational Data for Mission Planning & Flight Planning</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Instrument</p>
<p>National Airspace System</p> <p>Protocols: USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
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<p>Airspace Coordination and Restrictions</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)</p>
<p>Fuel/Battery Charge Requirements</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Performance and Limitations</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Operation of Aircraft Systems</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Global Positioning System (GPS) Considerations and Availability (If Applicable)</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Instrument, UAS Suggested Ground Lesson: SME</p>
<p>Communications <i>See also nav system/radar service</i></p>
<p>Communications Planning and Management/ Radio Comms./ Knowledge of Comm. Systems</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, UAS Suggested Ground Lesson: SME</p>

Weather Information <i>See also Adverse Weather</i>
Weather Information - Meteorology/meteor hazards/Volcanic Activity
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Instrument, Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME
Interpretation and use of weather products
Protocols: USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP
FLIGHT AUTHORIZATION, APPROVAL, AND CLEARANCE AUTHORITY
ATC Clearances and Instructions
Protocols: USAF: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME
PREFLIGHT PROCEDURES
Preflight Inspection/Equipment Examination
Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
Powerplant Start
Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
Taxiing
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
Runway Incursion Avoidance
Protocols: PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
Pre-takeoff Checks (Pre-Launch)
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
AIRPORT OPERATIONS (launch/landing area)
ATC Light Signals
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial

<p>Traffic Patterns</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Runway and Taxiway Signs, Markings, and Lighting</p> <p>Protocols: CASA Unmanned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Nontowered/Uncontrolled Field Procedures</p> <p>Protocols: USN/USMC: sUAS, PTS Private, UAS Suggested Ground Lesson: SME</p>
<p>Night Runway Operations</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, Part 61: (Commercial), PTS ATP</p>
<p>GENERAL FLIGHT OPERATIONS</p>
<p>Operational/Situation awareness</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, UAS Suggested Ground Lesson: SME</p>
<p>General Flight Rules</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)</p>
<p>Aviation Principles (Aerodynamics/Flight Principles)</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial)</p>
<p>Time & Course Control [Time and course control timing segments of flight and maintaining preplanned and assigned courses]</p> <p>Protocols: USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>
<p>Basic Manual Navigation</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA)</p>
<p>Manual Flight Control Skills [assumed in Manned]</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)</p>
<p>See and Avoid, Collision Avoidance Operations (TCAS), Terrain Awareness and Warning Systems (TAWS) (S & A Sensors, ground based S & A, detect & avoid, Proximity of Aircraft, separation)</p> <p>Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), CASA Both, JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), UAS Suggested Ground Lesson: SME</p>
<p>Right-of-Way Rules [General Operating and Flight Rules Regulations 14CFR Part 91: Right-of-Way]</p> <p>Protocols: CASA Unmanned, PTS Recreational (RPA), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>

<p>Aircraft Speed</p> <p>Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Commercial), PTS ATP</p>
<p>Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM) Systems and Procedures</p> <p>Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: ATP</p>
<p>Aircraft Lighting (if equipped)</p> <p>Protocols: CASA Unmanned, PTS Private, PTS Commercial, PTS ATP</p>
<p>Wake Turbulence and Wind Shear</p> <p>Protocols: USA: UAS (Hunter), USN/USMC: sUAS, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>Night Operations</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, Part 61: (Private), PTS Private, Part 61: (Commercial)</p>
<p>Takeoff with Ice or Frost</p> <p>Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Unmanned, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>TAKEOFF AND DEPARTURE</p>
<p>Takeoff and Departure - General [Noise abatement/Turns after Takeoff] <i>See Airport Ops for launch/landing</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial), Part 61: ATP, PTS ATP</p>
<p>Normal and Crosswind Takeoff and Climb</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, UAS Suggested Ground Lesson: SME</p>
<p>MANEUVERS</p>
<p>Performance Maneuvers – General</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), Part 61: ATP, PTS ATP</p>

EMERGENCY OPERATIONS
<p>Emergency Operations – General</p> <p>Protocols: USAF: (MQ-1) UAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, USA Suggested Ground Lesson: SME</p>
<p>Emergency Procedures [EP, declare emergency, lost link, unusual attitude, abnormal flight]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Instrument, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Unusual Attitude Recovery¹ <i>See also Emergency Procedures</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS ATP</p>
<p>Emergency Descent</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP</p>
<p>Emergency Approach and Landing</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>
<p>Systems and Equipment Malfunctions</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>
<p>Emergency Equipment (e.g., fire extinguisher)</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Powerplant Failure—Multiengine Airplane [if applicable]</p> <p>Protocols: USA: UAS (Hunter), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP</p>
<p>Powerplant Failure—Single-engine Airplane [or simulated]</p> <p>Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), Part 61: (Recreational), PTS ATP</p>
SLOW FLIGHT AND STALLS ²
<p>Slow Flight and Stalls – General</p> <p>Protocols: USN/USMC: sUAS, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Maneuvering During Slow Flight</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>

<p>Power-Off Stalls</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>
<p>Power-On Stalls</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>
<p>Accelerated Stalls</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Commercial</p>
<p>NAVIGATION</p>
<p>Navigation – General</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial)</p>
<p>Pilotage and Dead Reckoning [correlate w/ map]</p> <p>Protocols: USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Commercial), PTS Commercial, UAS Suggested Ground Lesson: SME</p>
<p>Navigation Systems and Radar Services/Integrated Navigation Systems</p> <p>Protocols: USAF: (MQ-9) UAS, CASA Unmanned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>
<p>Diversion</p> <p>Protocols: JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>
<p>LANDINGS AND APPROACHES TO LANDING</p>
<p>Landings and Approaches to Landing - General [Recovery]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Instrument, Part 61: (Commercial), Part 61: ATP, PTS ATP</p>
<p>Normal and Crosswind Approaches and Landings</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Short-Field Approach and Landing</p> <p>Protocols: USA: UAS (Hunter), PTS Private, PTS Commercial</p>
<p>Low Approaches or Closed Patterns [box pattern]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>

<p>Approach and Landing with Powerplant Failure</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>
<p>Go-Around/Rejected Landing/Touch & Go Landings</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP</p>
<p>Land and Hold Short Operations (LAHSO)</p> <p>Protocols: PTS Commercial, UAS Suggested Ground Lesson: SME</p>
<p>POSTFLIGHT PROCEDURES</p>
<p>Postflight Procedures – General</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>Post-Flight [post flight inspection/examination/checklists]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP</p>
<p>Parking and Securing</p> <p>Protocols: USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>VISUAL FLIGHT RULES (VFR)</p>
<p>Flight Operations under VFR</p> <p>Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS ATP, UAS Suggested Ground Lesson: SME</p>
<p>VFR Cloud Clearance and Visibility Minimums (FAA & ICAO Airspace Class) <i>See also Weather & NAS</i></p> <p>Protocols: CASA Both, PTS Private, PTS Commercial, UAS Suggested Ground Lesson: SME</p>
<p>INSTRUMENT FLIGHT RULES (IFR)</p>
<p>Instrument Flight Rules (IFR) - General [Adverse Weather/Inadvertent Weather entry]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, CASA Manned, JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS ATP</p>
<p>Navigation in IMC/Instrument procedures</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Unmanned, JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS Instrument, Part 61: ATP, PTS ATP</p>

NORMAL OPERATING PROCEDURES
Checklists
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME
SAFETY/OPERATIONAL RISK MANAGEMENT
Human Factors/Rest and Scheduling/Alertness Management Strategies
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME
Aeronautical decision making(ADM)/judgment/ORM Principles
Protocols: USAF: (MQ-1) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME
Crew/Cockpit Resource Management (CRM)
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME
REPORTING PROCEDURES
Mishap/System reporting (includes incidents)
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), Part 61: (Commercial)

¹Many UAS are programmed to prevent unusual attitudes. Unusual attitudes for many systems would be unrecoverable.

² Stalls are not possible for many UAS unless there is a failure that would likely be unrecoverable. For many systems you cannot command the aircraft to operate outside of its performance envelope.

The review of training protocols resulted in a significant amount of overlap between manned and unmanned training requirements identified by the services with the US DoD and the Australian CAA.

C. Not present in UAS training but present in the manned community with no apparent analogue in the UA environment

Two training requirements found in the manned community do not currently have an analog in the UAS protocols we reviewed (Table 4).

Table 4. Excluded from UAS

MANEUVERS	
Eights on Pylons, Chandelles, Lazy Eights Protocols: PTS Commercial	Manned
Emergency Equipment and Survival Gear Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	UAS, Manned

D. Additions from Manned: Not present in UAS training but present in the manned community with a possibility that such training might be included in some UA training protocols

There were a number of training requirements identified in manned training protocols that may have relevance to UAS training (Table 5). These requirements were not found in any of the reviewed UA training protocols although they may exist outside of the reviewed documentation.

Table 5. Manned Requirements, Potential Additions from Manned

Training Requirement – D. Additions from Manned	
TAKEOFF AND DEPARTURE	
Soft-Field Takeoff and Climb Protocols: PTS Private, PTS Commercial	
Short-Field Takeoff Protocols: PTS Private, PTS Commercial	
MANEUVERS	
Ground Reference Maneuvers Protocols: Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Commercial)	
Steep Turns Protocols: PTS Private, PTS Commercial, PTS ATP	
Steep Spiral Protocols: PTS Commercial	
SLOW FLIGHT AND STALLS	
Spins Protocols: Part 61: (Recreational), Part 61: (Private), PTS Private, PTS Commercial	
NAVIGATION	
Lost Procedures Protocols: PTS Private, PTS Commercial	

LANDINGS AND APPROACHES TO LANDING - GENERAL [Recovery]
Soft-Field Approach and Landing
Protocols: PTS Private, PTS Commercial
Land and Hold Short Operations (LAHSO)
Protocols: PTS Commercial, UAS Suggested Ground Lesson: SME

There were also a number of training requirements that were specific to UAS protocols that were not found in manned training (Table 2).

Requirements applicable to all reviewed training protocols are found in Table 7.

Table 6. Training Requirements Applicable to All Training Protocols

Training Requirement
POLICY AND RESPONSIBILITIES
Minimum training/currency Standards [frequency/recency/simulator/cockpit/#hrs/proficiency/flight/check]
FAA Advisory Circulars (ACs) and Technical Standard Orders (TSOs) [published] standards and regulations]
Records - Maintenance and disposition of [total flight time/ flight logs-training records/ engine time]
Maintenance of Aircraft/Equipment [performing/requesting mx]
PREFLIGHT PREPARATION
Pilot Certificates and Documents
Flight Planning (including Departure, Arrival, and Computerized Planning)
Crew Briefing <i>See also CRM in Safety/Operational Risk Mgmt.</i>
Navigational Chart/Map Reading
Map/Chart Preparation for Use During Flight
Publications
International Civil Aviation Organization (ICAO)/Flight Information Publications Procedures
Mission Route Selection & Analysis <i>See also Operational Data for Mission Planning & Flight Planning</i>
National Airspace System
Altitude Restrictions
Airspace Coordination and Restrictions
Fuel/Battery Charge Requirements
Performance and Limitations
Operation of Aircraft Systems
Global Positioning System (GPS) Considerations and Availability (If Applicable)
Communications <i>See also nav system/radar service</i>
Data Links (C2-command & control non-payload comm. CNPC) and Lost Link Procedures <i>See also Emergency Lost Link</i>
Communications Planning and Management/ Radio Comms./ Knowledge of Comm. Systems

Weather Information <i>See also Adverse Weather</i>
Weather Information - Meteorology/meteor hazards/Volcanic Activity
Interpretation and use of weather products
FLIGHT AUTHORIZATION, APPROVAL, AND CLEARANCE AUTHORITY
ATC Clearances and Instructions
PREFLIGHT PROCEDURES
Preflight Inspection/Equipment Examination
Powerplant Start
Pre-takeoff Checks [Pre-Launch]
AIRPORT OPERATIONS [launch/landing area]
Traffic Patterns
Nontowered/Uncontrolled Field Procedures
Night Runway Operations
GENERAL FLIGHT OPERATIONS
Operational/Situational awareness
General Flight Rules
Time & Course Control [Time and course control timing segments of flight and maintaining preplanned and assigned courses]
Basic Manual Navigation
Aircraft Speed
Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM) Systems and Procedures
Wake Turbulence and Wind Shear
Night Operations
TAKEOFF AND DEPARTURE
Normal and Crosswind Takeoff and Climb
EMERGENCY OPERATIONS
Emergency Procedures [EP, declare emergency, lost link, unusual attitude, abnormal flight]
Emergency Descent
Emergency Approach and Landing
Systems and Equipment Malfunctions
SLOW FLIGHT AND STALLS
Slow Flight and Stalls - General
NAVIGATION
Pilotage and Dead Reckoning [correlate w/ map]
LANDINGS AND APPROACHES TO LANDING
Landings and Approaches to Landing - General [Recovery]
Normal and Crosswind Approaches and Landings
Low Approaches or Closed Patterns [box pattern]

POSTFLIGHT PROCEDURES
Postflight Procedures - General
Post-Flight [post flight inspection/examination/checklists]
Parking and Securing
VISUAL FLIGHT RULES (VFR)
Flight Operations under VFR
NORMAL OPERATING PROCEDURES
Checklists
SAFETY/OPERATIONAL RISK MANAGEMENT
Human Factors/Rest and Scheduling/Alertness Management Strategies
Aeronautical decision making(ADM)/judgment/ORM Principles
Crew/Cockpit Resource Management (CRM)
REPORTING PROCEDURES
Mishap/System reporting (includes incidents)

There are numerous unmanned training programs unavailable for inclusion in this review. It is likely those unavailable or restricted programs cover more extensive and in-depth topics than the published programs currently included. Additionally, the rapid developments in unmanned training and operations may have resulted in the surveyed programs adding materials since the date of their last open source publication.

Findings in the Context of Existing Practical Test Standards

The following section places the findings of this effort in the context of existing manned practical test standards (PTS). Specifically, the historical UAS training program requirements are embedded in the Private, Commercial, and Instrument PTSs.

Private

Recommended Private UAS Aeronautical Knowledge, Flight Proficiency, and PTS Requirements

[**Bold, bracketed text**] indicates items in UAS training not found in the manned PTSs and ~~strikethroughs~~ indicate requirements from the manned PTSs not found in the reviewed UAS training protocols.

Private pilot aeronautical knowledge.

(a) *General. A person who is applying for a private pilot certificate must receive and log ground training from an authorized instructor or complete a home-study course on the aeronautical knowledge areas of paragraph (b) of this section that apply to the aircraft category and class rating sought.*

(b) Aeronautical knowledge areas.

(1) *Applicable Federal Aviation Regulations of this chapter that relate to private pilot privileges, limitations, and flight operations;*

(2) *Accident reporting requirements of the National Transportation Safety Board;*

(3) *Use of the applicable portions of the "Aeronautical Information Manual" and FAA advisory circulars;*

(4) *Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems; [where applicable]*

(5) *Radio communication procedures; [including frequency coordination and CNPC management]*

(6) *Recognition of critical weather situations from the ground and in flight, windshear avoidance, and the procurement and use of aeronautical weather reports and forecasts;*

(7) *Safe and efficient operation of aircraft, including collision avoidance [with the assistance of visual observers where applicable], and recognition and avoidance of wake turbulence;*

(8) *Effects of density altitude on takeoff and climb performance;*

(9) *Weight and balance computations;*

(10) *Principles of aerodynamics, powerplants, and aircraft systems;*

(11) *Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings;*

(12) *Aeronautical decision making and judgment; and*

(13) *Preflight action that includes--*

- (i) *How to obtain information on runway lengths at airports of intended use, data on takeoff and landing distances, weather reports and forecasts, and fuel requirements; and*
- (ii) *How to plan for alternatives if the planned flight cannot be completed or delays are encountered.*

Private pilot flight proficiency.

(a) *General. A person who applies for a private pilot certificate must receive and log ground and flight training from an authorized instructor on the areas of operation of this section that apply to the aircraft category and class rating sought.*

(b) *Areas of operation.*

(1) *For an airplane category rating with a single-engine class rating:*

- (i) *Preflight preparation;*
- (ii) *Preflight procedures; [including **Control Station checks**]*
- (iii) *Airport, [**launch/recovery area**], and seaplane base operations;*
- (iv) *Takeoffs/**Launch**, landings/**Recovery**, and go-arounds;*
- (v) *Performance maneuvers;*
- (vi) *Ground reference maneuvers;*
- (vii) *Navigation;*
- (viii) *Slow flight and stalls; [**where applicable**]*
- (ix) *Basic instrument maneuvers;*
- (+) ***UAS handoff procedures;***
- (x) *Emergency operations; [**including lost link**]*
- (xi) *Night operations, except as provided in Sec. 61.110 of this part;*

and

(xii) *Postflight procedures.*

(2) *For an airplane category rating with a multiengine class rating:*

- (i) *Preflight preparation;*
- (ii) *Preflight procedures; [including **Control Station checks**]*
- (iii) *Airport, [**launch/recovery area**], and seaplane base operations;*
- (iv) *Takeoffs/**Launch**, landings/**Recovery**, and go-arounds;*
- (v) *Performance maneuvers;*
- (vi) *Ground reference maneuvers;*
- (vii) *Navigation;*
- (viii) *Slow flight and stalls; [**where applicable**]*
- (ix) *Basic instrument maneuvers;*
- (+) ***UAS handoff procedures;***
- (x) *Emergency operations; [**including lost link**]*
- (xi) *Multiengine operations;*

(xii) *Night operations, except as provided in Sec. 61.110 of this part;*
and
(xiii) *Postflight procedures.*

(3) *For a rotorcraft category rating with a helicopter class rating:*
(i) *Preflight preparation;*
(ii) *Preflight procedures; [including Control Station checks]*
(iii) *Airport, [launch/recovery area], and heliport operations;*
(iv) *Hovering maneuvers;*
(v) *Takeoffs/Launch, landings/Recovery, and go-arounds;*
(vi) *Performance maneuvers;*
(vii) *Navigation;*
(+) *UAS handoff procedures;*
(viii) *Emergency operations; [including lost link]*
(ix) *Night operations, except as provided in Sec. 61.110 of this part;*
and
(x) *Postflight procedures.*

(4) *For a rotorcraft category rating with a gyroplane class rating:*
(i) *Preflight preparation;*
(ii) *Preflight procedures; [including Control Station checks]*
(iii) *Airport, [launch/recovery area], operations;*
(iv) *Takeoffs/Launch, landings/Recovery, and go-arounds;*
(v) *Performance maneuvers;*
(vi) *Ground reference maneuvers;*
(vii) *Navigation;*
(+) *UAS handoff procedures;*
(viii) *Flight at slow airspeeds;*
(ix) *Emergency operations; [including lost link]*
(x) *Night operations, except as provided in Sec. 61.110 of this part;*
and
(xi) *Postflight procedures.*

(5) *For a powered-lift category rating:*
(i) *Preflight preparation;*
(ii) *Preflight procedures; [including Control Station checks]*
(iii) *Airport, [launch/recovery area], and heliport operations;*
(iv) *Hovering maneuvers;*
(v) *Takeoffs/Launch, landings/Recovery, and go-arounds;*
(vi) *Performance maneuvers;*

- (vii) *Ground reference maneuvers;*
 - (viii) *Navigation;*
 - (+) ***UAS handoff procedures;***
 - (ix) *Slow flight and stalls; [where applicable]*
 - (x) *Basic instrument maneuvers;*
 - (xi) *Emergency operations; [including lost link]*
 - (xii) *Night operations, except as provided in Sec. 61.110 of this part;*
- and
- (xiii) *Postflight procedures.*

[Without additional data, retaining the aeronautical experience requirements as instantiated for manned certification might be the most propitious starting point for certification within the UAS community. Experience may indicate that these values can be changed in the future.]

****Glider/airship/balloon/powered parachute/weight-shift-control not shown.***

Private pilot Practical Test Standards (PTS)

I. PREFLIGHT PREPARATION

- A. Certificates and Documents (ASEL and ASES) [including COAs]*
- B. Airworthiness Requirements (ASEL and ASES)*
- C. Weather Information (ASEL and ASES)*
- D. Cross-Country Flight Planning (ASEL and ASES)*
- E. National Airspace System (ASEL and ASES)*
- F. Performance and Limitations (ASEL and ASES)*
- G. Operation of Systems (ASEL and ASES)*
- H. Water and Seaplane Characteristics (ASES)*
- I. Seaplane Bases, Maritime Rules, and Aids to Marine Navigation (ASES)*
- ~~*J. Aeromedical Factors (ASEL and ASES)*~~

II. PREFLIGHT PROCEDURES

- A. Preflight Inspection (ASEL and ASES)*
- ~~*B. Cockpit*~~ ***[Control Station] Management (ASEL and ASES)***
- C. Engine Starting (ASEL and ASES)*
- D. Taxiing (ASEL) [where applicable]*
- E. Taxiing and Sailing (ASES) [where applicable]*
- F. Runway Incursion Avoidance (ASEL and ASES) [where applicable]*
- G. Before Takeoff Check (ASEL and ASES)*

III. AIRPORT AND SEAPLANE BASE OPERATIONS

- A. Radio Communications and ATC Light Signals (ASEL and ASES)*
- B. Traffic Patterns (ASEL and ASES)*

C. Airport/Seaplane Base, Runway, and Taxiway Signs, Markings, and Lighting (ASEL and ASES)

IV. TAKEOFFS or LAUNCH, LANDINGS or RECOVERY, AND GO-AROUNDS

A. Normal and Crosswind Takeoff/Launch and Climb (ASEL and ASES)

B. Normal and Crosswind Approach and Landing/Recovery (ASEL and ASES)

C. Soft-Field Takeoff and Climb (ASEL) [where applicable]

D. Soft-Field Approach and Landing (ASEL) [where applicable]

E. Short-Field (Confined Area—ASES) Takeoff and Maximum Performance Climb (ASEL and ASES) [where applicable]

F. Short-Field Approach (Confined Area—ASES) and Landing (ASEL and ASES) [where applicable]

G. Glassy Water Takeoff and Climb (ASES)

H. Glassy Water Approach and Landing (ASES)

I. Rough Water Takeoff and Climb (ASES)

J. Rough Water Approach and Landing (ASES)

K. Forward Slip to a Landing (ASEL and ASES)

L. Go-Around/Rejected Landing (ASEL and ASES)

V. PERFORMANCE MANEUVER

A. Steep Turns (ASEL and ASES)

VI. GROUND REFERENCE MANEUVER

A. Rectangular Course (ASEL and ASES)

B. S-turns (ASEL and ASES)

C. Turns Around a Point (ASEL and ASES)

VII. NAVIGATION

A. Pilotage and Dead Reckoning (ASEL and ASES) [where applicable]

B. Navigation Systems and Radar Services (ASEL and ASES)

C. Diversion (ASEL and ASES)

D. Lost Procedures (ASEL and ASES) [where applicable]

VIII. SLOW FLIGHT AND STALLS

A. Maneuvering During Slow Flight (ASEL and ASES)

B. Power-Off Stalls (ASEL and ASES) [where applicable]

C. Power-On Stalls (ASEL and ASES) [where applicable]

D. Spin Awareness (ASEL and ASES)

IX. BASIC INSTRUMENT MANEUVERS

A. Straight-and-level Flight (ASEL and ASES)

B. Constant Airspeed Climbs (ASEL and ASES)

C. Constant Airspeed Descents (ASEL and ASES)

D. Turns to Headings (ASEL and ASES)

E. Recovery From Unusual Flight Attitudes (ASEL and ASES) [where applicable]

F. Radio Communications, Navigation Systems/Facilities and Radar Services (ASEL and ASES)

X. EMERGENCY OPERATIONS

A. Emergency Descents (ASEL and ASES)

B. Emergency Approach and Landing (Simulated) (ASEL and ASES)

C. Systems and Equipment Malfunctions (ASEL and ASES)

D. Emergency Equipment ~~and Survival Gear~~ (ASEL and ASES)

E. Lost link procedures

XI. NIGHT OPERATION

A. Night Preparation (ASEL and ASES)

XII. POSTFLIGHT PROCEDURES

A. After Landing, Parking, and Securing (ASEL and ASES)

B. Anchoring (ASES)

C. Docking and Mooring (ASES)

D. Ramping/Beaching (ASES)

Commercial

Recommended Commercial UAS Aeronautical Knowledge, Flight Proficiency, and PTS Requirements

[**Bold, bracketed text**] indicates suggested additions and ~~strikethroughs~~ indicate suggested deletions.

Commercial aeronautical knowledge.

(a) *General. A person who applies for a commercial pilot certificate must receive and log ground training from an authorized instructor, or complete a home-study course, on the aeronautical knowledge areas of paragraph (b) of this section that apply to the aircraft category and class rating sought.*

(b) Aeronautical knowledge areas.

(1) *Applicable Federal Aviation Regulations of this chapter that relate to commercial pilot privileges, limitations, and flight operations;*

(2) *Accident reporting requirements of the National Transportation Safety Board;*

(3) *Basic aerodynamics and the principles of flight;*

(4) *Meteorology to include recognition of critical weather situations, windshear recognition and avoidance, and the use of aeronautical weather reports and forecasts;*

(5) *Safe and efficient operation of aircraft;*

(6) *Weight and balance computations;*

(7) *Use of performance charts;*

(8) *Significance and effects of exceeding aircraft performance limitations;*

(9) *Use of aeronautical charts ~~and a magnetic compass~~ for pilotage and dead reckoning; [**where applicable**]*

(10) *Use of air navigation facilities;*

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(11) *Aeronautical decision making and judgment;*

(12) *Principles and functions of aircraft systems;*

(13) *Maneuvers, procedures, and emergency operations appropriate to the aircraft;*

(14) *Night ~~and high-altitude~~ operations;*

(15) *Procedures for operating within the National Airspace System; and*

(16) *Procedures for flight and ground training for lighter-than-air ratings.*

Commercial flight proficiency.

(a) *General.* A person who applies for a commercial pilot certificate must receive and log ground and flight training from an authorized instructor on the areas of operation of this section that apply to the aircraft category and class rating sought.

(b) *Areas of operation.*

(1) *For an airplane category rating with a single-engine class rating:*

- (i) *Preflight preparation;*
- (ii) *Preflight procedures; [including **Control Station checks**]*
- (iii) *Airport, [**launch/recovery area**], and seaplane base operations;*
- (iv) *Takeoffs/**Launch**, landings/**Recovery**, and go-arounds;*
- (v) *Performance maneuvers;*
- (vi) *Ground reference maneuvers;*
- (vii) *Navigation;*
- (+) ***UAS handoff procedures;***
- (viii) *Slow flight and stalls; [**where applicable**]*
- (ix) *Emergency operations; [**including lost link**]*
- ~~(x) *High-altitude operations; and*~~
- (xi) *Postflight procedures.*

(2) *For an airplane category rating with a multiengine class rating:*

- (i) *Preflight preparation;*
- (ii) *Preflight procedures; [including **Control Station checks**]*
- (iii) *Airport, [**launch/recovery area**], and seaplane base operations;*
- (iv) *Takeoffs/**Launch**, landings/**Recovery**, and go-arounds;*
- (v) *Performance maneuvers;*
- (vi) *Navigation;*
- (+) ***UAS handoff procedures;***
- (vii) *Slow flight and stalls; [**where applicable**]*
- (viii) *Emergency operations; [**including lost link**]*
- (ix) *Multiengine operations;*
- ~~(x) *High-altitude operations; and*~~
- (xi) *Postflight procedures.*

(3) *For a rotorcraft category rating with a helicopter class rating:*

- (i) *Preflight preparation;*
- (ii) *Preflight procedures; [including **Control Station checks**]*
- (iii) *Airport, [**launch/recovery area**], and heliport operations;*
- (iv) *Hovering maneuvers;*
- (v) *Takeoffs/**Launch**, landings/**Recovery**, and go-arounds;*
- (vi) *Performance maneuvers;*
- (vii) *Navigation;*

- (+) **UAS handoff procedures;**
- (viii) *Emergency operations; [including lost link]*
- (ix) *Special operations; and*
- (x) *Postflight procedures.*

- (4) *For a rotorcraft category rating with a gyroplane class rating:*
- (i) *Preflight preparation;*
 - (ii) *Preflight procedures; [including Control Station checks]*
 - (iii) *Airport, [launch/recovery area], operations;*
 - (iv) *Takeoffs/Launch, landings/Recovery, and go-arounds;*
 - (v) *Performance maneuvers;*
 - [(vi)] *Ground reference maneuvers;]*
 - [(vii)] *Navigation;*
 - (+) **UAS handoff procedures;**
 - [(viii)] *Flight at slow airspeeds;*
 - [(ix)] *Emergency operations; [including lost link] and*
 - [(x)] *Postflight procedures.*

- (5) *For a powered-lift category rating:*
- (i) *Preflight preparation;*
 - (ii) *Preflight procedures; [including Control Station checks]*
 - (iii) *Airport, [launch/recovery area], and heliport operations;*
 - (iv) *Hovering maneuvers;*
 - (v) *Takeoffs/Launch, landings/Recovery, and go-arounds;*
 - (vi) *Performance maneuvers;*
 - (vii) *Ground reference maneuvers;*
 - (+) **UAS handoff procedures;**
 - [(viii)] *Slow flight and stalls; [where applicable]*
 - [(ix)] *Emergency operations; [including lost link]*
 - ~~[(x)] *High altitude operations;*~~
 - [(xi)] *Special operations; and*
 - [(xii)] *Postflight procedures.*

[Without additional data, retaining the aeronautical experience requirements as instantiated for manned certification might be the most propitious starting point for certification within the UAS community. Experience may indicate that these values can be changed in the future.]

****Glider/airship/balloon/powered parachute/weight-shift-control not shown.***

Commercial Practical Test Standards (PTS).

I. PREFLIGHT PREPARATION

- A. *Certificates and Documents (ASEL and ASES) [including COAs]*
- B. *Airworthiness Requirements (ASEL and ASES)*
- C. *Weather Information (ASEL and ASES)*
- D. *Cross-Country Flight Planning (ASEL and ASES)*
- E. *National Airspace System (ASEL and ASES)*
- F. *Performance and Limitations (ASEL and ASES)*
- G. *Operation of Systems (ASEL and ASES)*
- H. *Water and Seaplane Characteristics (ASES)*
- I. *Seaplane Bases, Maritime Rules, and Aids to Marine Navigation (ASES)*
- J. ~~*Aeromedical Factors (ASEL and ASES)*~~

II. PREFLIGHT PROCEDURES

- A. *Preflight Inspection (ASEL and ASES)*
- B. ~~*Control Station*~~ **[Control Station]** *Management (ASEL and ASES)*
- C. *Engine Starting (ASEL and ASES)*
- D. *Taxiing (ASEL) [where applicable]*
- E. *Taxiing and Sailing (ASES) [where applicable]*
- F. *Runway Incursion Avoidance (ASEL and AES) [where applicable]*
- G. *Before Takeoff Check (ASEL and ASES)*

III. AIRPORT AND SEAPLANE BASE OPERATIONS

- A. *Radio Communications and ATC Light Signals (ASEL and ASES)*
- B. *Traffic Patterns (ASEL and ASES)*
- C. *Airport/Seaplane Base, Runway, and Taxiway Signs, Markings, and Lighting (ASEL and ASES)*

IV. TAKEOFFS, LANDINGS, AND GO-AROUNDS

- A. *Normal and Crosswind Takeoff and Climb (ASEL and ASES)*
- B. *Normal and Crosswind Approach and Landing (ASEL and ASES)*
- C. *Soft-Field Takeoff and Climb (ASEL) [where applicable]*
- D. *Soft-Field Approach and Landing (ASEL) [where applicable]*
- E. *Short-Field (Confined Area—ASES) Takeoff and Maximum Performance Climb (ASEL and ASES) [where applicable]*
- F. *Short-Field Approach (Confined Area—ASES) and Landing (ASEL and ASES) [where applicable]*
- G. *Glassy Water Takeoff and Climb (ASES)*
- H. *Glassy Water Approach and Landing (ASES)*
- I. *Rough Water Takeoff and Climb (ASES)*
- J. *Rough Water Approach and Landing (ASES)*

- K. Power-Off 180° Accuracy Approach and Landing (ASEL and ASES)*
- L. Go-Around/Rejected Landing (ASEL and ASES)*

V. PERFORMANCE MANEUVERS

- A. Steep Turns (ASEL and ASES)*
- B. Steep Spiral (ASEL and ASES)*
- ~~*C. Chandelles (ASEL and ASES)*~~
- ~~*D. Lazy Eights (ASEL and ASES)*~~

VI. GROUND REFERENCE MANEUVER

- ~~*A. Eights on Pylons (ASEL and ASES)*~~

VII. NAVIGATION

- A. Pilotage and Dead Reckoning (ASEL and ASES) [where applicable]*
- B. Navigation Systems and Radar Services (ASEL and ASES)*
- C. Diversion (ASEL and ASES)*
- D. Lost Procedures (ASEL and ASES) [where applicable]*

VIII. SLOW FLIGHT AND STALLS

- A. Maneuvering During Slow Flight (ASEL and ASES)*
- B. Power-Off Stalls (ASEL and ASES) [where applicable]*
- C. Power-On Stalls (ASEL and ASES) [where applicable]*
- D. Accelerated Stalls (ASEL and ASES) [where applicable]*
- E. Spin Awareness (ASEL and ASES)*

IX. EMERGENCY OPERATIONS

- A. Emergency Descents (ASEL and ASES)*
- B. Emergency Approach and Landing (Simulated) (ASEL and ASES)*
- C. Systems and Equipment Malfunctions (ASEL and ASES)*
- ~~*D. Emergency Equipment and Survival Gear (ASEL and ASES)*~~
- E. Lost link procedures***

X. ~~HIGH ALTITUDE OPERATIONS~~

- ~~*A. Supplemental Oxygen (ASEL and ASES)*~~
- ~~*B. Pressurization (ASEL and ASES)*~~

XI. POSTFLIGHT PROCEDURES

- A. After Landing, Parking, and Securing (ASEL and ASES)*
- B. Anchoring (ASES)*
- C. Docking and Mooring (ASES)*
- D. Ramping/Beaching (ASES)*

Instrument

Recommended Instrument UAS Aeronautical Knowledge, Flight Proficiency, and PTS Requirements

[**Bold, bracketed text**] indicates suggested additions and ~~strikethroughs~~ indicate suggested deletions.

***Instrument rating aeronautical knowledge.** A person who applies for an instrument rating must have received and logged ground training from an authorized instructor or accomplished a home-study course on the following aeronautical knowledge areas that apply to the instrument rating sought:*

(1) Federal Aviation Regulations of this chapter that apply to flight operations under IFR;

(2) Appropriate information that applies to flight operations under IFR in the “Aeronautical Information Manual;”

(3) Air traffic control system and procedures for instrument flight operations;

(4) IFR navigation and approaches by use of navigation systems;

(5) Use of IFR en route and instrument approach procedure charts;

(6) Procurement and use of aviation weather reports and forecasts and the elements of forecasting weather trends based on that information and personal observation of weather conditions;

(7) Safe and efficient operation of aircraft under instrument flight rules and conditions;

(8) Recognition of critical weather situations and windshear avoidance;

(9) Aeronautical decision making and judgment; and

(10) Crew resource management, including crew communication and coordination.

***Instrument rating flight proficiency.** A person who applies for an instrument rating must receive and log training from an authorized instructor in an aircraft, or in a flight simulator or flight training device, in accordance with paragraph (g) of this section, that includes the following areas of operation:*

(1) Preflight preparation;

(2) Preflight procedures; [including Control Station checks]

(3) Air traffic control clearances and procedures;

(4) Flight by reference to instruments; [no video feed]

(5) Navigation systems;

(6) Instrument approach procedures;

(7) Emergency operations; [including lost link] and

(8) Postflight procedures.

(d) *Aeronautical experience for the instrument-airplane rating. A person who applies for an instrument-airplane rating must have logged: [Without additional data, retaining the aeronautical experience requirements as instantiated for manned certification might be the most propitious starting point for certification within the UAS community. Experience may indicate that these values can be changed in the future.]*

(1) *Except as provided in paragraph (g) of this section, 50 hours of cross-country flight time as pilot in command, of which 10 hours must have been in an airplane; and*

(2) *Forty hours of actual or simulated instrument time in the areas of operation listed in paragraph (c) of this section, of which 15 hours must have been received from an authorized instructor who holds an instrument-airplane rating, and the instrument time includes:*

(i) *Three hours of instrument flight training from an authorized instructor in an airplane that is appropriate to the instrument-airplane rating within 2 calendar months before the date of the practical test; and*

(ii) *Instrument flight training on cross country flight procedures, including one cross country flight in an airplane with an authorized instructor, that is performed under instrument flight rules, when a flight plan has been filed with an air traffic control facility, and that involves—*

(A) *A flight of 250 nautical miles along airways or by directed routing from an air traffic control facility;*

(B) *An instrument approach at each airport; and*

(C) *Three different kinds of approaches with the use of navigation systems.*

Instrument Practical Test Standards (PTS).

I. PREFLIGHT PREPARATION

A. Pilot Qualifications

B. Weather Information

C. Cross-Country Flight Planning

II. PREFLIGHT PROCEDURES

A. Aircraft Systems Related to IFR Operations

B. ~~Aircraft Flight~~ Instruments/CS Displays and Navigation Equipment

C. Instrument ~~Cockpit~~ [Control Station] Check

III. AIR TRAFFIC CONTROL CLEARANCES AND PROCEDURES

A. Air Traffic Control Clearances

B. Compliance With Departure, En Route, and Arrival Procedures and Clearances

C. Holding Procedures

IV. FLIGHT BY REFERENCE TO INSTRUMENTS

A. Basic Instrument Flight Maneuvers (IA, IH, PL, AA, HA, PLA, PC)

B. Recovery From Unusual Flight Attitudes [where applicable]

V. NAVIGATION SYSTEMS

A. Intercepting and Tracking Navigational Systems and DME Arcs

VI. INSTRUMENT APPROACH PROCEDURES

A. Nonprecision Approach (NPA)

B. Precision Approach (PA)

C. Missed Approach

D. Circling Approach

E. Landing From a Straight-In or Circling Approach

VII. EMERGENCY OPERATIONS

A. Loss of Communications

*B. One Engine Inoperative During Straight-and-Level Flight and Turns
(Multiengine Airplane)*

C. One Engine Inoperative—Instrument Approach (Multiengine Airplane)

D. Approach With Loss of Primary Flight Instrument Indicators

E. Lost link procedures

VIII. POSTFLIGHT PROCEDURES

A. Checking Instruments and Equipment

SUMMARY

The high degree of overlap between manned and unmanned training protocols was evident throughout the analysis. The commonalities are also reflected in the recently released Part 107 rule for Small Unmanned Aerial Systems (sUAS). As UAS operations begin to supplant some manned operations (e.g. agriculture, law enforcement) it is likely that the high degree of commonality will continue based on the similarity between the manned and unmanned missions.

Differences in interfaces, levels of autonomy, and missions will probably cause increasing divergence between manned and unmanned protocols in some instances. However, the fundamental training such as airspace, meteorology, and flight planning should result in a common baseline from which all pilots in the NAS start their training.

As UAS operations and systems continue to evolve, the training will undoubtedly require reanalysis and modification. There are numerous unmanned training programs unavailable for inclusion in this review. It is likely those unavailable or restricted programs cover more extensive and in-depth topics than the published programs currently include. Additionally, the rapid developments in unmanned training and operations may have resulted in the surveyed programs adding materials since the date of their last open source publication.

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APPENDIX A

Table A1. Requirements Checklist

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(0):	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [I + II]	JCS: BUQ-III (instrument) [I + II + II]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)
POLICY AND RESPONSIBILITIES																					
Minimum training/currency Standards [frequency/recency/simulator/co ckpit/#hrs/proficiency flight/check]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FAA Advisory Circulars (ACs) and Technical Standard Orders (TSOs) [published] standards and regulations]	X					X	X				X		X		X						X
Waiver Authority [authority to grant the waiver and under what conditions]	X	X	X	X		X		X	X	X									X		
Records - Maintenance and disposition of [total flight time/ flight logs-training records/ engine time]	X	X	X	X	X	X	X	X	X	X	X		X		X		X		X		X
Maintenance of Aircraft/Equipment [performing/requesting mx]		X	X	X		X	X							X							X

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(O)	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [I+II]	JCS: BUQ-III (instrument) [I+II+III]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)	
PREFLIGHT PREPARATION																						
Pilot Certificates and Documents	X	X	X	X	X	X	X	X	X	X						X	X	X	X			X
Aircraft Certification, Airworthiness and Documents [registration, operating limitation documents, weight and balance information, and any other documents required by regulation, CS documentation]											X	X	X	X		X	X	X	X	X	X	X
Certificates of Authorization (COA)	X					X	X															X
Operational Data for Mission Planning		X	X	X	X	X		X	X	X												X
Airworthiness Requirements [airframe, subsystem failure checklist, Compliance with all Airworthiness Directives, Minimum Equipment List items, etc.]			X				X	X	X	X				X		X		X			X	X
Maintenance Logs [track unit device training]		X	X		X			X	X	X				X		X		X			X	
Flight Planning (including Departure, Arrival, and Computerized Planning)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(O):	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [+II]	JCS: BUQ-III (instrument) [+II + II]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)	
Crew Briefing [CRM located in Safety/Operational Risk Mgmt below]		X	X	X	X	X	X	X	X	X					X		X		X	X	X	
Navigational Chart/Map Reading				X	X	X		X	X	X				X			X		X	X	X	
Map/Chart Preparation for Use During Flight		X	X	X	X	X		X	X	X	X	X	X		X			X	X			X
Publications	X	X	X	X		X	X	X	X	X								X				
International Civil Aviation Organization (ICAO)/Flight Information Publications Procedures					X	X	X	X	X	X											X	
Mission Route Selection & Analysis <i>See also Operational Data for Mission Planning & Flight Planning</i>		X	X		X	X		X	X	X						X						
National Airspace System						X	X	X	X	X		X		X		X	X	X		X	X	
Altitude Restrictions	X			X		X	X	X	X	X						X					X	X
Airspace Coordination and Restrictions	X	X	X	X		X	X	X	X	X												
Frequency Coordination	X	X		X	X	X		X	X	X												
Fuel/Battery Charge Requirements		X	X	X	X	X	X	X	X	X	X		X			X		X		X	X	X

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Performance and Limitations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Operation of Aircraft Systems	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X
Global Positioning System (GPS) Considerations and Availability (If Applicable)		X	X			X		X	X	X						X						X
Visual Observers [safety O, Supervising O, line of sight O]							X															X
Control Station (CS) System Checks [checklist/procedures for CS]		X	X	X		X	X	X	X	X												X
Communications <i>See also nav system/radar service</i>																						
Data Links (C2-command & control non-payload comm. CNPC) and Lost Link Procedures <i>See also Emergency Lost Link</i>		X	X	X	X	X	X	X	X	X												X
Communications Planning and Management/ Radio Comms./ Knowledge of Comm. Systems		X	X		X	X	X	X	X	X		X	X	X	X	X		X				X
Weather Information <i>See also Adverse Weather</i>																						

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(O)	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [+II]	JCS: BUQ-III (instrument) [+II + II]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)	
Weather Information - Meteorology/meteor hazards/Volcanic Activity		X	X	X	X	X	X	X	X	X		X				X	X		X			X
Interpretation and use of weather products			X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X		
FLIGHT AUTHORIZATION, APPROVAL, AND CLEARANCE AUTHORITY																						
Flight Authorization [Local SOPS Found - not shown]																						
Approval Authority [Non-regulatory Organization Approval (e.g., local commander)]																						
Approval Requirements [Military specific (e.g., time in service, rank Found - not shown)]																						
ATC Clearances and Instructions	X				X	X	X	X	X	X					X	X		X	X	X	X	X
PREFLIGHT PROCEDURES																						
Preflight Inspection/Equipment Examination					X	X	X	X	X	X				X		X		X		X		X
Powerplant Start [engine start]					X	X		X	X	X	X	X	X	X				X		X		X
Taxiing		X	X		X				X	X				X				X		X		X

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Runway Incursion Avoidance														X		X		X		X	X	
Pre-takeoff Checks (Pre-Launch)		X	X		X	X	X	X	X	X				X		X		X		X	X	
AIRPORT OPERATIONS (launch/landing area)																						
ATC Light Signals								X	X	X				X				X				
Traffic Patterns		X	X			X		X	X	X		X		X				X		X	X	
Runway and Taxiway Signs, Markings, and Lighting							X		X	X	X	X	X	X				X		X	X	
Nontowered/Uncontrolled Field Procedures						X								X								X
Launch/Recovery Areas		X	X	X	X	X																X
Night Runway Operations		X	X	X	X	X											X				X	
GENERAL FLIGHT OPERATIONS																						
Operational/Situational awareness		X	X	X		X		X	X	X				X		X		X				X
General Flight Rules		X	X			X	X	X	X	X												
Aviation Principles (Aerodynamics/Flight Principles)								X	X	X	X		X				X					

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Time & Course Control [Time and course control timing segments of flight and maintaining preplanned and assigned courses]						X		X	X	X				X		X		X		X		
Basic Manual Navigation		X	X	X	X	X		X	X	X	X	X										
Manual Flight Control Skills [assumed in Manned]								X	X	X												
See and Avoid, Collision Avoidance Operations (TCAS), Terrain Awareness and Warning Systems (TAWS) (S & A Sensors, ground based S & A, detect & avoid, Proximity of Aircraft, separation)		X			X		X			X	X	X	X									X
Formation Flight/Cooperative Teaming/Swarming/Chase planes					X		X															
Right-of-Way Rules [General Operating and Flight Rules Regulations 14CFR Part 91: Right-of-Way]							X					X		X		X		X		X		X
Aircraft Speed				X	X	X		X	X	X		X	X	X			X			X		

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Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM) Systems and Procedures				X	X	X	X		X	X										X		
Aircraft Lighting (if equipped)							X							X				X		X		
Wake Turbulence and Wind Shear					X	X					X	X	X	X	X		X		X			X
Night Operations		X	X	X	X	X	X						X	X			X					
Night Vision Goggles (NVG) Operations [includes night vision device NVD]						X																
Takeoff with Ice or Frost			X		X		X									X				X		X
UAS Hand-off Procedures		X	X			X																X
TAKEOFF AND DEPARTURE																						
Takeoff and Departure - General [Noise abatement/Turns after Takeoff] <i>See Airport Ops for launch/landing</i>		X	X		X		X	X	X	X	X		X				X			X	X	
Normal and Crosswind Takeoff and Climb		X	X		X	X		X	X	X				X				X				X
Soft-Field Takeoff and Climb														X				X				

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Short-Field Takeoff														X				X				
MANEUVERS																						
Performance Maneuvers - General								X	X	X	X		X	X	X	X	X		X	X		
Ground Reference Maneuvers											X		X	X			X					
Eights on Pylons																		X				
Steep Turns														X				X		X		
Steep Spiral																		X				
Chandelles																		X				
Lazy Eights																		X				
EMERGENCY OPERATIONS																						
Emergency Operations - General		X					X	X	X	X	X		X	X	X	X	X	X	X	X		X
Emergency Procedures [EP, declare emergency, lost link, unusual attitude, abnormal flight]	X	X	X	X	X	X	X	X	X	X						X			X	X		X
Unusual Attitude Recovery <i>See also Emergency Procedures</i>		X	X					X	X	X			X		X					X		
Emergency Descent		X	X			X		X	X	X				X				X		X		

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Emergency Approach and Landing		X	X			X		X	X	X				X				X				
Systems and Equipment Malfunctions	X	X	X	X	X			X	X	X				X		X		X		X		
Emergency Equipment and Survival Gear								X	X	X				X				X		X	X	
Powerplant Failure—Multiengine Airplane [if applicable]					X								X	X		X	X	X		X		
Powerplant Failure—Single-engine Airplane [or simulated]			X		X						X									X		
SLOW FLIGHT AND STALLS																						
Slow Flight and Stalls - General						X					X	X	X	X		X	X			X	X	
Maneuvering During Slow Flight								X	X	X				X				X				
Power-Off Stalls								X	X	X				X				X				
Power-On Stalls								X	X	X				X				X				
Accelerated Stalls								X	X	X								X				
Spins											X		X	X					X			
NAVIGATION																						
Navigation - General								X	X	X	X		X				X					

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Pilotage and Dead Reckoning [correlate w/ map]					X	X		X	X	X	X		X	X			X	X				X
Navigation Systems and Radar Services/Integrated Navigation Systems			X				X	X	X	X		X		X	X	X		X	X			X
Diversion									X	X				X				X				
Lost Procedures														X				X				
LANDINGS AND APPROACHES TO LANDING																						
Landings and Approaches to Landing - General [Recovery]		X	X			X	X	X	X	X	X		X			X	X		X	X		
Normal and Crosswind Approaches and Landings		X	X		X	X		X	X	X				X				X		X		X
Automatic Approach & Landing		X			X	X		X	X	X												
Soft-Field Approach and Landing														X					X			
Short-Field Approach and Landing					X									X				X				
Low Approaches or Closed Patterns [box pattern]		X	X			X			X	X		X		X		X		X		X		
Approach and Landing with Powerplant Failure		X	X		X									X		X		X		X		

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Go-Around/Rejected Landing/Touch & Go Landings		X	X		X			X	X	X	X		X	X		X	X	X		X		
Landing from a Circling Approach																X				X		
Landing from a No Flap or a Nonstandard Flap Approach																				X		
Land and Hold Short Operations (LAHSO)																		X			X	
POSTFLIGHT PROCEDURES																						
Postflight Procedures - General		X	X	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X	X
Post-Flight [post flight inspection/examination/checklists]		X	X	X	X	X	X	X	X	X				X				X		X		
Parking and Securing						X		X	X	X				X				X		X	X	
VISUAL FLIGHT RULES (VFR)																						
Flight Operations under VFR		X			X	X	X	X	X	X	X		X							X	X	
VFR Cloud Clearance and Visibility Minimums (FAA & ICAO Airspace Class) See also Weather & NAS							X							X				X			X	

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(O)	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [I+II]	JCS: BUQ-III (instrument) [I+II+III]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)	
INSTRUMENT FLIGHT RULES (IFR)																						
Instrument Flight Rules (IFR) - General [Adverse Weather/Inadvertent Weather entry]		X	X				X			X					X							
Navigation in IMC/Instrument procedures		X	X		X		X			X					X	X			X	X		
NORMAL OPERATING PROCEDURES																						
Checklists		X	X	X	X	X		X	X	X				X		X		X		X	X	X
Video/Data Capture [surveillance/camera]		X	X	X	X	X	X															X
SAFETY/OPERATIONAL RISK MANAGEMENT																						
Safety/Operational Risk Management - General <i>See also Human Factors, ADM & ORM, CRM</i>														X				X				
Human Factors/Rest and Scheduling/Alertness Management Strategies		X	X	X		X	X	X	X	X		X		X				X	X			X

Training Requirement	USAF: sUAS	USAF: (MQ-1) UAS (Predator)	USAF: (MQ-9) UAS (Reaper)	USA: sUAS (Raven, Scan Eagle, TACMAV)	USA: UAS (Hunter)	USN/USMC: sUAS	CASA Manned & Unmanned AC 101-1(O):	JCS: BUQ-I (Recreational) [I]	JCS: BUQ-II (private) [+II]	JCS: BUQ-III (instrument) [+II + II]	Part 61: (Recreational)	PTS Recreational (RPA)	Part 61: (Private)	PTS Private	Part 61:65 (Instrument)	PTS Instrument	Part 61: (Commercial)	PTS Commercial	Part 61: (ATP)	PTS ATP	UAS: Suggested Ground Lesson (SME)	
Aeronautical decision making(ADM)/judgment/ORM Principles		X		X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X
Crew/Cockpit Resource Management (CRM)		X	X		X	X	X	X	X	X				X	X	X		X	X	X	X	X
REPORTING PROCEDURES																						
Mishap/System reporting (includes incidents)					X	X	X				X	X	X				X					

APPENDIX B

Table 6. Evaluated Manned and Unmanned Training Requirements with Corresponding Protocols

Training Requirement	UAS, sUAS, Manned or All
POLICY AND RESPONSIBILITIES	
<p>Minimum training/currency Standards [frequency/recency/simulator/cockpit/#hrs/proficiency flight/check]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA:sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>FAA Advisory Circulars (ACs) and Technical Standard Orders (TSOs) [published standards and regulations]</p> <p>Protocols: USAF: sUAS, USN/USMC: sUAS, CASA Unmanned, Part 61 (Recreational), Part 61 (Private), Part 61 (Instrument), UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Records - Maintenance and disposition of [total flight time/ flight logs-training records/ engine time]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Instrument), Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Maintenance of Aircraft/Equipment [performing/requesting mx]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA - BOTH, PTS Recreational (RPA), UAS Suggested Ground Lesson: SME</p>	ALL 3
PREFLIGHT PREPARATION	
<p>Pilot Certificates and Documents</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA:sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Commercial), PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3

<p>Aircraft Certification, Airworthiness and Documents [registration, operating limitation documents, weight and balance information, and any other documents required by regulation, CS documentation]</p> <p>Protocols: Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>	UAS, Manned
<p>Certificates of Authorization (COA)</p> <p>Protocols: USAF: sUAS, USN/USMC: sUAS, UAS Suggested Ground Lesson:SME</p>	UAS, sUAS
<p>Operational Data for Mission Planning</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), UAS Suggested Ground Lesson: SME</p>	UAS, sUAS
<p>Airworthiness Requirements [airframe, subsystem failure checklist, Compliance with all Airworthiness Directives, Minimum Equipment List items, etc.]</p> <p>Protocols: USAF: (MQ-9) UAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	UAS, Manned
<p>Maintenance Logs [track unit device training]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP</p>	UAS, Manned
<p>Flight Planning (including Departure, Arrival, and Computerized Planning)</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Crew Briefing <i>See also CRM in Safety/Operational Risk Mgmt</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61 (Instrument), Part 61 (Commercial), Part 61 ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Navigational Chart/Map Reading</p> <p>Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, Part 61: (Commercial), Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3

<p>Map/Chart Preparation for Use During Flight</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), Part 61: (Instrument), PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Publications</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Commercial</p>	ALL 3
<p>International Civil Aviation Organization (ICAO)/Flight Information Publications Procedures</p> <p>Protocols: USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS ATP</p>	ALL 3
<p>Mission Route Selection & Analysis <i>See also Operational Data for Mission Planning & Flight Planning</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Instrument</p>	ALL 3
<p>National Airspace System</p> <p>Protocols: USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Altitude Restrictions</p> <p>Protocols: USAF: sUAS, USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Instrument, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Airspace Coordination and Restrictions</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)</p>	ALL 3
<p>Frequency Coordination [CNPC/command and control frequencies]</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)</p>	UAS, sUAS

<p>Fuel/Battery Charge Requirements</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	<p>ALL 3</p>
<p>Performance and Limitations</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME</p>	<p>ALL 3</p>
<p>Operation of Aircraft Systems</p> <p>Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	<p>ALL 3</p>
<p>Global Positioning System (GPS) Considerations and Availability (If Applicable)</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Instrument, UAS Suggested Ground Lesson: SME</p>	<p>ALL 3</p>
<p>Visual Observers¹ [safety O, Supervising O, line of sight O]</p> <p>Protocols: CASA Unmanned, UAS Suggested Ground Lesson: SME</p>	<p>UAS</p>
<p>Control Station (CS) System Checks [checklist/procedures for CS]</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), UAS Suggested Ground Lesson: SME</p>	<p>UAS, sUAS</p>
<p>Communications <i>See also nav system/radar service</i></p>	
<p>Data Links (C2-command & control non-payload comm. CNPC) and Lost Link Procedures <i>See also Emergency Lost Link</i></p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), UAS Suggested Ground Lesson: SME</p>	<p>UAS, sUAS</p>

Communications Planning and Management/ Radio Comms./ Knowledge of Comm. Systems Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, UAS Suggested Ground Lesson: SME	ALL 3
Weather Information <i>See also Adverse Weather</i>	
Weather Information - Meteorology/meteor hazards/Volcanic Activity Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Instrument, Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME	ALL 3
Interpretation and use of weather products Protocols: USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP	ALL 3
FLIGHT AUTHORIZATION, APPROVAL, AND CLEARANCE AUTHORITY	
Flight Authorization [Local SOPS Found - not shown]	N/A
Approval Authority [Non-regulatory Organization Approval (e.g., local commander)]	N/A
Approval Requirements [Military specific (e.g., time in service, rank Found - not shown)]	N/A
ATC Clearances and Instructions Protocols: USAF: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
PREFLIGHT PROCEDURES	
Preflight Inspection/Equipment Examination Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Powerplant Start [engine start] Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Taxiing	UAS, Manned

<p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	
<p>Runway Incursion Avoidance</p> <p>Protocols: PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	UAS, Manned
<p>Pre-takeoff Checks (Pre-Launch)</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>AIRPORT OPERATIONS (launch/landing area)</p>	
<p>ATC Light Signals</p> <p>Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial</p>	UAS, Manned
<p>Traffic Patterns</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Runway and Taxiway Signs, Markings, and Lighting</p> <p>Protocols: CASA Unmanned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS ATP, UAS Suggested Ground Lesson: SME</p>	UAS, Manned
<p>Nontowered/Uncontrolled Field Procedures</p> <p>Protocols: USN/USMC: sUAS, PTS Private, UAS Suggested Ground Lesson: SME</p>	ALL 3
<p>Launch/Recovery Areas (e.g., Rail, slingshot, and hand-thrown launches; net and arresting cable recoveries)</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, UAS Suggested Ground Lesson: SME</p>	UAS, sUAS
<p>Night Runway Operations</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, Part 61: (Commercial), PTS ATP</p>	ALL 3
<p>GENERAL FLIGHT OPERATIONS</p>	
<p>Operational/Situational awareness</p> <p>Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, UAS Suggested Ground Lesson: SME</p>	ALL 3

General Flight Rules	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)	ALL 3
Aviation Principles (Aerodynamics/Flight Principles) ²	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial)	UAS, Manned
Time & Course Control [Time and course control timing segments of flight and maintaining preplanned and assigned courses]	
Protocols: USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP	ALL 3
Basic Manual Navigation	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA)	ALL 3
Manual Flight Control Skills [assumed in Manned]	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)	UAS, Manned
See and Avoid, Collision Avoidance Operations; Traffic Collision Avoidance System (TCAS), Terrain Awareness and Warning Systems (TAWS) (S & A Sensors, ground based S & A, detect & avoid, Proximity of Aircraft, separation)	
Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), CASA Both, JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), UAS Suggested Ground Lesson: SME	UAS, Manned
Formation Flight/Cooperative Teaming/Swarming/Chase planes	
Protocols: USA:UAS (Hunter), CASA Unmanned	UAS
Right-of-Way Rules [General Operating and Flight Rules Regulations 14CFR Part 91: Right-of-Way]	
Protocols: CASA Unmanned, PTS Recreational (RPA), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	UAS, Manned
Aircraft Speed	
Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Commercial), PTS ATP	ALL 3
Communications, Navigation & Surveillance/Air Traffic Management (CNS/ATM) Systems and Procedures	
Protocols: USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: ATP	ALL 3
Aircraft Lighting (if equipped)	
Protocols: CASA Unmanned, PTS Private, PTS Commercial, PTS ATP	UAS, Manned

Wake Turbulence and Wind Shear	
Protocols: USA: UAS (Hunter), USN/USMC: sUAS, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, Part 61: (Instrument), Part 61: (Commercial), Part 61: ATP, UAS Suggested Ground Lesson: SME	ALL 3
Night Operations	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, Part 61: (Private), PTS Private, Part 61: (Commercial)	ALL 3
Night Vision Goggles (NVG) Operations [includes night vision device NVD]	
Protocols: USN/USMC: sUAS	sUAS
Takeoff with Ice or Frost	
Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Unmanned, Part 61: ATP, UAS Suggested Ground Lesson: SME	UAS, Manned
UAS Hand-off Procedures	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, UAS Suggested Ground Lesson: SME	UAS, sUAS
TAKEOFF AND DEPARTURE	
Takeoff and Departure - General [Noise abatement/Turns after Takeoff] <i>See Airport Ops for launch/landing</i>	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Both, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial), Part 61: ATP, PTS ATP	UAS, Manned
Normal and Crosswind Takeoff and Climb	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, UAS Suggested Ground Lesson: SME	ALL 3
Soft-Field Takeoff and Climb	
Protocols: PTS Private, PTS Commercial	Manned
Short-Field Takeoff	
Protocols: PTS Private, PTS Commercial	Manned
MANEUVERS	
Performance Maneuvers – General	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), Part 61: ATP, PTS ATP	UAS, Manned
Ground Reference Maneuvers	
Protocols: Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Commercial)	Manned
Eights on Pylons	Manned

Protocols: PTS Commercial	
Steep Turns	
Protocols: PTS Private, PTS Commercial, PTS ATP	Manned
Steep Spiral	
Protocols: PTS Commercial	Manned
Chandelles	
Protocols: PTS Commercial	Manned
Lazy Eights	
Protocols: PTS Commercial	Manned
EMERGENCY OPERATIONS	
Emergency Operations – General	
Protocols: USAF: (MQ-1) UAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, USA Suggested Ground Lesson: SME	UAS, Manned
Emergency Procedures [EP, declare emergency, lost link, unusual attitude, abnormal flight]	
Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), PTS Instrument, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Unusual Attitude Recovery <i>See also Emergency Procedures</i>	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS ATP	UAS, Manned
Emergency Descent	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP	ALL 3
Emergency Approach and Landing	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial	ALL 3
Systems and Equipment Malfunctions	
Protocols: USAF: sUAS, USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP	ALL 3

Emergency Equipment and Survival Gear	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	UAS, Manned
Powerplant Failure—Multiengine Airplane [if applicable]	
Protocols: USA: UAS (Hunter), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP	UAS, Manned
Powerplant Failure—Single-engine Airplane [or simulated]	
Protocols: USAF: (MQ-9) UAS, USA: UAS (Hunter), Part 61: (Recreational), PTS ATP	UAS, Manned
SLOW FLIGHT AND STALLS	
Slow Flight and Stalls – General	
Protocols: USN/USMC: sUAS, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Maneuvering During Slow Flight	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial	UAS, Manned
Power-Off Stalls	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial	UAS, Manned
Power-On Stalls	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial	UAS, Manned
Accelerated Stalls	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Commercial	UAS, Manned
Spins	
Protocols: Part 61: (Recreational), Part 61: (Private) PTS Private, PTS Commercial	Manned
NAVIGATION	
Navigation – General	
Protocols: JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), Part 61: (Commercial)	UAS, Manned
Pilotage and Dead Reckoning [correlate w/ map]	
Protocols: USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Commercial), PTS Commercial, UAS Suggested Ground Lesson: SME	ALL 3
Navigation Systems and Radar Services/Integrated Navigation Systems	UAS, Manned

Protocols: USAF: (MQ-9) UAS, CASA Unmanned, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME	
Diversion	
Protocols: JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial	UAS, Manned
Lost Procedures	
Protocols: PTS Private, PTS Commercial	Manned
LANDINGS AND APPROACHES TO LANDING	
Landings and Approaches to Landing - General [Recovery]	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Instrument, Part 61: (Commercial), Part 61: ATP, PTS ATP	ALL 3
Normal and Crosswind Approaches and Landings	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Automatic Approach & Landing	
Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument)	UAS, sUAS
Soft-Field Approach and Landing	
Protocols: PTS Private, PTS Commercial	Manned
Short-Field Approach and Landing	
Protocols: USA: UAS (Hunter), PTS Private, PTS Commercial	UAS, Manned
Low Approaches or Closed Patterns [box pattern]	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USN/USMC: sUAS, JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Instrument, PTS Commercial, PTS ATP	ALL 3
Approach and Landing with Powerplant Failure	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), PTS Private, PTS Instrument, PTS Commercial, PTS ATP	UAS, Manned
Go-Around/Rejected Landing/Touch & Go Landings	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, PTS Instrument, Part 61: (Commercial), PTS Commercial, PTS ATP	UAS, Manned

Landing from a No Flap or a Nonstandard Flap Approach	Manned
Protocols: PTS ATP	
Land and Hold Short Operations (LAHSO)	UAS, Manned
Protocols: PTS Commercial, UAS Suggested Ground Lesson: SME	
POSTFLIGHT PROCEDURES	
Postflight Procedures – General	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Post-Flight [post flight inspection/examination/checklists]	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP	ALL 3
Parking and Securing	
Protocols: USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
VISUAL FLIGHT RULES (VFR)	
Flight Operations under VFR	
Protocols: USAF: (MQ-1) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
VFR Cloud Clearance and Visibility Minimums (FAA & ICAO Airspace Class) See also Weather & NAS	
Protocols: CASA Both, PTS Private, PTS Commercial, UAS Suggested Ground Lesson: SME	UAS, Manned
INSTRUMENT FLIGHT RULES (IFR)	
Instrument Flight Rules (IFR) - General [Adverse Weather/Inadvertent Weather entry]	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, CASA Manned, JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS ATP	UAS, Manned
Navigation in IMC/Instrument procedures	
Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), CASA Unmanned, JCS: BUQ-III (Instrument), Part 61: (Instrument), PTS Instrument, Part 61: ATP, PTS ATP	UAS, Manned

NORMAL OPERATING PROCEDURES	
Checklists Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, PTS Instrument, PTS Commercial, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Video/Data Capture [surveillance/camera] Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, UAS Suggested Ground Lesson: SME	UAS, sUAS
SAFETY/OPERATIONAL RISK MANAGEMENT	
Safety/Operational Risk Management - General <i>See also Human Factors, ADM & ORM, CRM</i> Protocols: PTS Private, PTS Commercial	Manned
Human Factors/Rest and Scheduling/Alertness Management Strategies Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: sUAS, USN/USMC: sUAS, CASA Manned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Recreational (RPA), PTS Private, PTS Commercial, Part 61: ATP, UAS Suggested Ground Lesson: SME	ALL 3
Aeronautical decision making(ADM)/judgment/ORM Principles Protocols: USAF: (MQ-1) UAS, USA:sUAS, USA: UAS (Hunter), USN/USMC: sUAS, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), Part 61: (Recreational), Part 61: (Private), PTS Private, Part 61: (Instrument), PTS Instrument, Part 61: (Commercial), PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
Crew/Cockpit Resource Management (CRM) Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Unmanned, JCS: BUQ-I (Recreational), JCS: BUQ-II (Private), JCS: BUQ-III (Instrument), PTS Private, Part 61: (Instrument), PTS Instrument, PTS Commercial, Part 61: ATP, PTS ATP, UAS Suggested Ground Lesson: SME	ALL 3
REPORTING PROCEDURES	
Mishap/System reporting (includes incidents) Protocols: USAF: (MQ-1) UAS, USAF: (MQ-9) UAS, USA: UAS (Hunter), USN/USMC: sUAS, CASA Manned, Part 61: (Recreational), PTS Recreational (RPA), Part 61: (Private), Part 61: (Commercial)	ALL 3

¹Visual observers could be utilized for sUAS, but were not found in sUAS reviewed Protocols

²Aviation principles will likely be required for sUAS training, but were not found in sUAS reviewed Protocols